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TRANSLATION

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Annular composite workpieces and a cold-rolling method for producing said workpieces

The invention relates to annular composite workpieces, in particular rolling bearing rings, and a cold rolling method for the manufacturing thereof from at least two hollow cylindrical workpieces made of different materials or the same materials with different strength (in the following different materials).

Occasionally the production of this kind of rolling bearing rings is described in the literature.

According to DE 200 923, an unhardened reinforcement ring is placed over a hardened ring after it has been finish-machined and filled with balls. It is pointed out that the bearing can accept more balls because the hardened ring deforms elastically when filled. A bonded material structure and thus sufficient dynamic loadability cannot be reached with this solution.

In DE 27 45 527, the production of outer rings of rolling bearings by using cold rolling is described. Two rings with exactly the same volume made of different materials are fixedly connected to one another by skrinking, then roll formed, and afterwards finish- machined by turning and grinding. The advantages are above all seen in the combination of the material characteristics, here above all in the combination of a ball race of great hardness with excellent wear characteristics and a support ring of reduced hardness and strength that can then be processed more easily. During forming, the rings are deformed together tangentially, radially and axially at the same time. A fast connection of both rings is reached only in exceptional cases. Different materials generally have different expansion capacities so that the rings tend to separate (the shrink connection separates) rather than to remain fixed together. For the technical implementation of the method, a complex tool configuration made of several divided tool parts is necessary. The costs are high; the production spectrum is limited and greatly curtailed in regard to complicated profile cross sections. In spite

of the obvious advantages resulting from the potentially higher practical value of the composite rolling bearings, no large scale application of DE 27 45 527 is known.

The object of the invention is to efficiently produce annular composite workpieces, especially for high dynamic loads, made of at least two hollow cylindrical workpieces.

According to the invention, the object is solved for a method with the features of the preamble of claim 1 in that the hollow cylindrical workpieces are formed to a composite workpiece by means of a generally known axial roll forming method.

Furthermore, the object is solved by an annular composite workpiece with the features claimed in claim 7.

Advantageous variations and embodiments are the subject matter of the dependent claims.

Axial roll forming methods are known since 1972 at the latest. "When rolling, the material that is compressed by the penetration of the profile transversely to the axial direction of the workpiece is displaced laterally so far outwardly that across the original width of the workpiece ... protruding lateral boundary edges are formed." (DE 22 08 515 A1, page 2)

It was found that the at least two workpieces are fixedly connected to each other even when they had been placed only loosely into each other beforehand and had not been shrunk. The composite shows characteristics of a cold pressure welding connection; these characteristics are the result of pressing together the surfaces of the workpieces at very high pressure.

The workpieces preferably have such a play relative to one another that they can barely be joined by hand.

Since such a play is permissible, pipes, i.e. longer hollow cylindrical workpieces, can also be fit together in an uncomplicated manner.

Therefore, both the axial roll forming of rings (e.g. DE 22 08 515 A1) as well as the axial roll forming of pipes (e.g. DD 225 358 or DE 195 26 900) can be employed. With the latter method, the composite rings are produced especially efficiently and in a material saving way.

Both profiled outer and inner rolling bearing rings can be produced. The bearing races are made of high quality antifriction bearing steel, respectively. The support rings in contrast are made of a steel which is not as strong, which is cheaper and can be machined more easily, so that the overall costs for the rolling bearing ring is clearly lowered.

Also, composite rings made of steel in combination with nonferrous metals, in particular aluminum, can be produced, for example, in lightweight construction or for corrosion protection. Because the material selection is matched to the function, production costs are saved to a considerable extent and new use characteristics are obtained.

The invention is explained in more detail in the following with the aid of several embodiments based on the axial roll forming of pipes.

The drawings show in:

Fig. 1 the preparation of the pipes to be rolled,

Fig. 2 the production of inner rings of rolling bearings from two pipes,

Fig. 3 an individual inner ring of rolling bearings made from two pipes,

Fig. 4 the production of inner rings of rolling bearings from three pipes,

Fig. 5 the production of a gear ring from two hollow cylindrical workpieces,

Fig. 6 the production of outer rings of rolling bearings from two pipes,

Figs. 7 and 8 section and side view, respectively, of a tangential rolling method for a ring,

Figs. 9 and 10 section and side view, respectively, of an axial rolling method for a ring.

According to Fig. 1, two pipes 1 and 2 are prepared for forming. They are, if necessary, turned on the outside and turned on the inside and then inserted into one another.

In Fig. 2, the two pipes 1 and 2 are positioned on a rolling arbor 7 between two roll forming tools 6 for forming an outer profile. The profiled rolling tools 6 are diametrically opposed, are rotatable, and can be radially advanced. In addition, they are axially movable in order to follow the pipe elongations caused by axial material flow.

Fig. 3 shows the composite inner ring 8 of a rolling bearing completely ready for grinding after the steps of cropping and machining by cutting. The original pipes 1 and 2 now form the bearing race 1', e.g. made of high-strength antifriction bearing steel, and the thrust ring 2' made of a steel which is not as strong and easier to machine.

Fig. 4 shows the production of a composite inner ring 9 of a rolling bearing made of three workpieces 3, 4 and 5. The workpieces 3 and 5, formed as pipes, consist of different steels in analogy to the first variant; workpiece 4 is made of aluminum. It can intentionally be kept thick (lightweight construction) or can be only a thin, e.g.

vapo deposited, layer in order to promote the connection of the workpieces 3 and 5 during rolling of the composite in analogy to cold pressure welding.

Fig. 5 shows the production of a gear ring 10 from two pipes 1 and 2 with two roll forming tools 6 for forming an outer profile and a rolling arbor 7. The workpieces 1 and 2 are made of steel materials of different strength.

Fig. 6 shows the production of a composite outer ring 11 of a rolling bearing. The high-strength pipe 1 forms again the bearing race and is now located on the inside in comparison to Fig. 2 or Fig. 3.

In all variants, it is ensured that the material, above all in the area of the bordering layers, can flow freely axially almost during the entire forming process.

In order to prevent possible misunderstandings in regard to the term of axial roll forming of rings or pipes, the definitions of tangential and of axial roll forming of rings used in the instant description are compared and explained with the aid of the Figures 7 to 8 and 9 to 10, respectively.

Fig. 7 and Fig. 8 show in section and in side view, respectively, the tangential roll forming of a workpiece 1 between a profiled roll forming tool 6 and a rolling arbor 7. The arrows shown with solid black tips (in a longitudinal direction of the page) show the pressure of the tools 6 and 7 on the workpiece 1. The pressure acts radially. The arrows with the blank tips (in a transverse direction of the page) show the primary direction of the material flow. The material flow is tangential in respect to the surface line or the circular center core of the workpiece 1 illustrated in Fig. 8. Characteristic for the tangential roll forming is the enlargement of the workpiece diameter. In addition, the shoulder height of the workpiece 1 decreases.

Fig. 9 and Fig. 10 show in section and side view, respectively, the axial roll forming of a workpiece 1 between two diametrically opposed roll forming tools 6a and 6b and a rolling arbor 7. The tools 6a, 6b and 7 press radially against the workpiece 1. The

material flows predominantly axially. Characteristic for the axial roll forming process is the enlargement of the width of the workpiece. The width increases at least by the amount that corresponds to the volume of the rolled-in groove.

List of reference numerals

- 1 - workpiece
- 1' – bearing race
- 2 - workpiece
- 2' – support ring
- 3 - workpiece
- 4 – workpiece
- 5 – workpiece
- 6, 6a, 6b – roll-forming tool for forming outer profile
- 7 – rolling arbor
- 8 – composite inner ring of rolling bearing
- 9 – composite inner ring of rolling bearing
- 10 - gear ring
- 11 – composite outer ring of rolling bearing